E/CONF.39/A/221
31 Oct.1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item: A.4.2.5

United Nations

NEW SOURCES OF ENERGY AND ENERGY DEVELOPMENT : A RESUME OF THE UNITED NATIONS CONFERENCE ON NEW SOURCES OF ENERGY

By the Department of Economic and Social Affairs,
United Nations, New York

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NOTES

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2. Papers selected for inclusion in Specialized Sessions will be available at the Conference in only one of the above official languages.

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NEW SOURCES OF ENERGY AND ENERGY DEVELOPMENT

A résumé of the United Nations Conference on New Sources of Energy

by

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1. The United Nations Conference on New Sources of Energy was held in Rome, Italy, from 21 through 31 August 1961, for the purposes of: exchange of ideas and experience in the applications of three new sources of energy, namely, solar energy, wind power and geothermal energy (natural steam and hot water); consideration of how techniques can be brought into wider use, particularly for the benefit of less developed areas; and provision of up-to-date information on progress achieved and on the potentialities of as well as the limitations in utilizing these three sources of energy, especially in those areas lacking conventional energy sources or facing high energy costs.

2. The Conference[1/] represented the culmination of various steps in this field upon the initiative of the United Nations Economic and Social Council, including the publication in 1957 of a major study entitled New Sources of Energy and Economic Development.[2/] A comprehensive report on the Conference was subsequently submitted to the Council under the same title as this paper, which is a summary.[3/] The Council in July 1962 acted upon this latest report as indicated briefly in the concluding section.

Use of new energy sources in different energy situations

3. The key note of the Conference in dealing with various aspects of solar, wind and geothermal energy was the fact that the availability of energy in many different forms is a pre-condition for economic development and that in meeting energy needs the different sources of energy had to be carefully distinguished in terms of their special characteristics in relation to each other and to the socio-economic structure in which they are to be developed and used. Thus, in considering the non-conventional sources of energy and their possibilities for development, the alternative energy sources and the state of economic development had to be considered in the context of each region and country or group of countries.

1/ The Conference had a registered attendance of 447 persons representative of a wide range of professional disciplines and organizational backgrounds and drawn from seventy-four countries and territories in all parts of the world. A total of 250 individual papers (including 77 on geothermal energy, 40 on wind power, 118 on solar energy and 15 general) and 20 rapporteurs' reports were submitted to the Conference; they are being prepared for printing in five volumes.

2/ United Nations publication, Sales No.: 57.II.B.1.

3/ United Nations publication, Sales No.: 62.I.21.

4. Among the relevant background facts, it was pointed out that world consumption of energy is anticipated to double and redouble by the end of the century. On a per capita basis, energy consumption was shown to vary greatly throughout the world. The low average consumption figures for the developing countries, however, conceal further disparities between urban and rural areas and the fact that about two-thirds of the world's population are living without electricity supply.

5. Special attention therefore was drawn to different energy situations which, in the under-developed countries, could be divided into three major types. Broadly speaking, it was concluded that for areas with electric grid systems and developed energy supply, wind power and solar energy may be unimportant unless cost studies can show that they could provide power and other useful energy at competitive rates, while geothermal energy, if available, might be far more economic than any other source. In areas with isolated power stations - usually characterized by high fuel and generating costs - solar and wind power might well be useful supplementary sources effecting fuel savings, and geothermal energy, if available and exploitable, would provide cheap energy.

6. For many of the areas in a third category - entirely lacking electricity, by far the most typical in the under-developed countries and for which large-scale rural and village electrification cannot be foreseen for a long time - wind or solar energy offer the only prospect of a power supply. And they might become important factors in ameliorating depressed living conditions and in spurring economic change by providing energy for telecommunications, conservation of perishable foodstuffs, water pumping and simple processing and manufacturing.

7. In this connexion, and particularly with regard to the many possible applications of solar energy, it was noted that in terms of certain broad social objectives the new sources were not limited by the consideration of economic viability as applicable to advanced industrial societies. Nor was it considered necessary that energy development follow the same path as it had in industrial countries. The question was rather one of either providing no energy at all or of providing it even in an imperfect and limited form, to create worthwhile work and productive effort, as judged on the basis of social as well as economic considerations.

8. It was made abundantly clear that the new sources provided no panacea and were characterized by certain limitations in their geographical locations. It was suggested that several obstacles, such as customs, traditions and lack of training, could be overcome, at least in part, through the establishment of demonstration centres, the provision of technical assistance and the improvement and diffusion of knowledge about the availability and the possible uses of the three energy sources.

Geothermal energy

9. The possibilities and full significance of finding and utilizing natural steam and hot water from underground sources have not been generally appreciated. The Conference sessions on geothermal energy may well mark a turning point in this regard. It was the first occasion - in terms of people and purpose - where there was a concerted effort to bring together the relevant available knowledge on the subject and thereby open new vistas and interests.

10. Natural steam is now driving electricity generating plants with a capacity of nearly 400,000 kilowatts, about three-fourths of it in Italy and the rest in new plants in New Zealand, the United States, Mexico and elsewhere. Geothermal energy also heats the homes of some 45,000 people in Iceland and finds many other applications.

11. One of the most serious limitations to its growing use lies in the fact that little is known of the physical availability of geothermal energy, except where hot springs and other readily apparent surface evidence exists, such as in and around the entire Pacific basin, the Atlantic ridge, the Rift Valley in East Africa and some other areas, usually of a volcanic nature. It was noted, however, that the presence of steam is not necessarily limited to volcanic regions or to areas with surface manifestations. Italy provides a clear illustration of this. It was pointed out that there might be unsuspected geothermal possibilities in many countries which have not so far been studied and which might be assisted to determine whether development was worth while. In fact, considerable optimism on finding geothermal resources was expressed.

12. Geothermal energy is found and developed through techniques in many ways similar to, though in some important respects different from, those used in the petroleum industry. These include prospecting on the basis of geological, geophysical and other surveys and the drilling of wells. The applicable prospecting techniques are now well developed but the quantitative knowledge and result in the case of geothermal energy resources are still modest largely because field survey work and drilling, which alone can give final proof, have been undertaken on a meagre scale. Also, there admittedly remains some uncertainty as to the length of productive life of steam wells once they have been developed.

13. Techniques of utilizing geothermal steam are well developed on the basis of the experience with the various types of power plant now in operation. For new regions one of the most interesting types is the simple monobloc unit. This plant combines a turbine and generator with a capacity of up to 3,500 kilowatts in one easily transportable piece that operates directly on the steam as it comes out of the well and discharges it to the air. Other types in operation are larger and incorporate different steam cycles to get more power out of the steam or to recover chemical by-products. With the exception of Iceland, electric power production is currently and prospectively the most important form in which geothermal energy is utilized. The Icelandic experience suggests that, in some areas, conditions may favour the use of geothermal steam for hot water supply, space heating in homes and industries and various processing applications requiring heat in the 100-300° C. range.

14. Geothermal power generation, it was concluded, has many attractive features, among them avoidance of boilers and fuel (including imported fuel), continuity of supply, simplicity of plant and low operating costs. Where available, the effective energy can also be extremely cheap, in existing cases giving power in the cost range of from 0.2 to one U.S. cent per kilowatt-hour and thus comparing favourably with any conventional plants. Under favourable conditions, geothermal power can thus compete with energy from any other source and should be attractive to both industrial and developing countries.

15. The initial costs - for the power plant and especially for the exploration and drilling - are such, however, that in the opinion of the Conference experts, the installation must have a minimum size of about 1,000 kilowatts to be economic. For good economy it is further necessary to utilize the capacity at a high load-factor in order to draw full advantage from the relatively high initial investment and low running costs. Before investments are made in detailed prospection and, of course, before capital is committed to drilling and plant construction in subsequent stages, the possibility of absorbing a minimum power load has to be given early consideration along with preliminary surveys of surface manifestations and other indications of geothermal resources.

16. With the existing advanced techniques and the promise of often low power costs, the prospects of increased utilization now depend mostly on an intensification of exploration for geothermal resources.

17. There is no doubt that the work of the Conference will lead to new thinking about the role of geothermal energy in many countries where the necessary potentialities may be present. The achievements and experiences already gained - from California in the west to Kamchatka and Japan in the east and from Iceland in the north to New Zealand in the south - indicate that geothermal resources are a promising source of energy.

Wind power

18. The sessions on wind power utilization indicated that there was a revival of interest in this source of energy and in new techniques for harnessing it to productive purposes, in capacities ranging from small machines for water pumping and electricity generation to large machines (up to some 900 kilowatts at present) for connexion to power networks. It was recognized that there was still considerable scope for the simple traditional windmills, chiefly for water pumping in under-developed areas lacking rural electrification as in India where a project is currently under way to install some 200 windmills of domestic design.

19. Great importance was attached to site selection and wind measurements. Attention was called to the usefulness of long-period records collected at meteorological stations. Wind measurements at such stations however have not been based on wind power requirements and therefore usually have to be supplemented with wind surveys aimed at practical applications and with special measurements for testing purposes.

20. As regards the design and operating behaviour of wind power plants, the technical advances presented in the Conference were numerous; the general feeling was that enough was now known to enable manufacturing and installation in considerable numbers and that design no longer posed fundamental problems nor held out prospects of major technical "breakthrough".

21. The technical possibilities of wind power production thus were shown to be well established. They should, however, be distinguished from the economic possibilities. From the economic point of view, the experts insisted, a further distinction should be made between large wind power plants and small machines of less than about five kilowatts which can be used on individual farms and in other small applications. The larger machines would have to be used in areas with a grid system, that is in industrialized areas, where their justification would have to be made entirely on competitive grounds such as by saving of fuels.

22. Medium-size windmills - in the ten to fifty kilowatt range and usually envisaged for operation at the village level in conjunction with diesel or other stand-by units to overcome the intermittence of wind supply - might well be economic as fuel savers and competitive, particularly since, in contrast to diesel units, they do not require constant supervision and maintenance.

23. Most of the interest, however, centred on small machines for which many possible applications in the less developed areas were mentioned. It was indicated that the cost of power from small machines would obviously be higher than that from larger machines, but in the energy situations under consideration the relative height of power cost was of less importance. In many circumstances, even intermittent supply or only limited battery storage capacity could be tolerated. It was emphasized that the first few kilowatts introduced were the most important, not only in terms of their economic contribution but also in lightening the load of manual labour and improving the conditions of life of the rural population.

Solar energy

24. The solar energy sessions took up a major part of the Conference. In their variety they reflected the widespread efforts in this field as well as the numerous possible applications, several of which were considered to be of great importance for the less developed areas. The specialists were impressed with the need for the early application of solar energy to meet specific requirements, such as the production of power on a small scale, the manufacture of ice for food preservation, the distillation of water for drinking and the production of other items and services most applicable to the needs of the less developed areas.

25. In the industrialized countries, solar energy is likely to find application for such purposes as solar furnaces for research, solar power in space vehicles and water heating. But solar energy is likely to find its most important utilization in the less developed countries, according to the consensus of views expressed. Two main reasons were advanced: first, in the foreseeable future solar energy may be regarded mainly as a supplementary rather than as a competitive source of energy particularly suitable in areas lacking conventional energy, and second, the availability of solar energy is most favourable in the belt, between latitudes 40° North and 40° South, in which most of the under-developed countries are located.

26. Harnessing the low-intensity energy of the solar radiation calls for more efficient devices and a lowering of the costs of collectors. Since the energy-flux is low, a large collection area is required and the reflecting or flat-plate collector accounts for the bulk of the cost of the useful energy; hence an increased conversion efficiency reduces the area needed to obtain a given quantity of useful energy. Improved efficiency is in part dependent on the materials utilized and their properties as absorbing surfaces, transparent covers or reflecting surfaces; these are making rapid progress with the advance in materials technology. The efficiency of photovoltaic cells which convert sunlight directly to electricity, for example, has been increased a hundredfold during the past decade. The introduction of new materials, such as specially adapted transparent plastics and aluminized plastic reflecting surfaces has also contributed towards a reduction in the cost per area unit.

27. Most solar applications are now at the experimental or "pilot-plant" stage. In a few cases they have reached a commercial scale (as indicated below) but further efforts are necessary to bring them into widespread practical use under realistic operating conditions. Solar applications appear to hold the greatest promise in the form of relatively small units which can take advantage of the ubiquitous distribution of the energy and minimize transmission distribution costs.

28. The needs and possibilities for utilizing solar energy processes obviously have to be assessed in the context of the particular energy situations that prevail in the various regions of the world. Specific applications of particular importance and promise to the less developed countries include uses of solar energy for power production and for water heating, cooling and distillation.

29. The production of mechanical and electric power through solar heat engines has long been a goal. Some novel ideas presented in Rome, notably by Israeli scientists, included a small solar-powered electric generating plant in the two to ten kilowatt range which promises to be truly competitive in many locations; it incorporates a new turbine operating on organic vapour at unusually high efficiency, a novel type of balloon-like plastic mirror collector and a heat storage system allowing night operation at reduced load.

30. Converting solar energy directly to electricity by means of thermoelectric or photovoltaic devices is another approach receiving perhaps the greatest development efforts under the impetus of space research. The devices are expensive so that, except for very small loads such as those used in radio and other communications systems, the application will be very limited unless scientific and technological progress cuts the costs. There is reason to be optimistic: costs have been cut by about two-thirds in the past three years alone.

31. Possibly the most promising progress has been made in the development of thermoelectric generator systems, which are based on a temperature gradient creating an electric current. Small solar-powered generators may soon appear on the market for such purposes as water pumping in remote regions; moreover, in these small applications, the solar collector part of the unit may also be used for solar cooking and other purposes.

32. Considerable progress has been made with respect to the photovoltaic devices which convert sunlight or high energy photons directly to electricity. Silicon cell devices, for example, have found a large application in communication systems, in radios, in remote lighthouses and in a variety of applications where only a few watts are needed. This range includes spectacular use in space satellites as well as simple radio loudspeaker systems in remote villages. For photovoltaic devices to find extensive use in applications requiring kilowatts rather than watts, however, such as in pumping and in homes and small industries, there will have to be a very substantial reduction from the current cost of $100,000 or more per kilowatt. Several proposals and experiments considered in the Conference may in fact go a long way towards bringing about such a development.

33. The possible applications of solar energy for purposes other than power generation are many. With the notable exception of solar water heating, most of them are still in the experimental and development stage and need further verification and advance through research in laboratories, pilot projects and larger-scale field trials in the areas where they are most likely to be used.

34. Refrigeration and other methods of food preservation by solar energy were revealed by the Conference proceedings as perhaps the most important possible applications outside the solar power field in the less developed areas. One of the most promising solutions would be the introduction of ice making with solar energy through small plants now available in prototype and shown to be capable of producing ice at reasonable cost.

35. Solar drying, the subject of another session, has been rather neglected despite its large traditional role in drying grains, fruits, vegetables, fish and other products. Large amounts of food and money could be saved by the introduction of modern adaptations to traditional techniques and equipment.

36. With respect to the production of fresh water through solar distillation of sea or brackish water, family size units for drinking water are well known, within reach and easily made locally at a cost of perhaps ten to thirty dollars per square metre producing about 1,500 to 2,000 litres per year. These small stills are of increasing importance and merit greater attention. Larger solar distillation units (exceeding, say, 50,000 litres a day) for urban areas, industry and irrigation are more questionable, since alternative and apparently cheaper methods of production exist.

37. Solar water heating is the widest current application yet established on a commercial basis. In Japan, annual sales are as high as 100,000 units, ranging in price from about $6 up to much higher figures for more durable, complex units. The future for solar heaters is bright but it could be improved still further through standardization, simplification and cost reduction.

38. House heating with solar energy, which is of little importance in warm areas, is still in the experimental stage and not yet generally economically feasible. The prospects may, however, become brighter, particularly if heating can be successfully combined with air conditioning, and if heat storage can be improved to overcome the lack of coincidence between energy supply and need.

39. Solar cooker developments appear to have reached a point where practical application may be imminent. Workable cookers presented in the Conference appear technically capable of supplementing, to a substantial extent, the cooking needs of peoples in sunny climates. Reductions in equipment cost, currently about $15, are a prerequisite to extensive utilization.

40. Solar furnaces (now up to 1,000 kilowatts) have unique qualities for high-temperature processing and research. In the view of the specialists their use will become more widespread and may compete with conventional furnaces in the processing of high-priced mineral and chemical products.

Problems of energy storage and combination of sources

41. There was a deep awareness at all sessions of the one big handicap of wind power and solar energy, namely the intermittence of supply. The problem centred on the need to overcome this limitation through energy storage and by

other means. For several applications, however, the specific timing of the supply is relatively unimportant, as in water pumping, and the energy can be utilized as it becomes available.

42. Research is needed to improve and substantially reduce the cost of storage of heat and power from solar and wind energy and to find new ways of overcoming the intermittence problem.

43. At present, the direct storage devices are limited in practice mainly to conventional storage batteries, which are useful for small loads but prohibitively expensive for large electric supplies, and to storage of low-temperature heat.

44. The intermittence problem can be solved also by combining different energy sources. Especially interesting for less developed areas are the proposals considered during the Conference for combining solar and wind energy and energy from other local sources, such as waste materials, into comprehensive schemes at the village level to meet the various energy needs.

Conclusions

45. Solar, wind and geothermal energy - as demonstrated in the Conference - promise to make a significant contribution to energy supply and economic growth, especially in the less developed countries.

46. The encouraging results of experiments and applications revealed by the Conference were noted by the Economic and Social Council when in July 1962 it invited the Secretary-General of the United Nations to arrange for widespread dissemination of the report on the Conference, to facilitate access to the papers presented to the Conference, and to present in early 1964 a progress report including an examination of methods of co-ordinating and facilitating research into the new sources of energy and their applications. In doing so, the Council took into account "the desirability, in view of the scarcity of capital in the developing countries, of making use of all sources of energy which are readily available, and especially of those sources of energy which can be utilized comparatively cheaply". Moreover, it noted the following implications derived from the proceedings of the Conference, namely: "(a) that scientific and technological research, including fundamental research, is essential to increasing the use and yield of these new sources of energy, as is adaptation of devices and field testing in conditions prevailing in the developing countries; (b) that there is room for much greater co-ordination of research activities and for more efficient utilization and expansion of the funds and technical manpower already going into solar research; (c) that more information is needed on the availability of solar, wind and geothermal energy, together with more complementary information on alternative energy sources and on the problems of energy storage and the use in combination of various energy sources; (d) that there is a need for standardization of measurements, instruments and equipment to facilitate the wider adoption of new energy utilization techniques; and (e) that if significant progress is to be made in application of new sources of energy, particularly solar energy and wind power, pilot centres and experimental stations must be established in less developed areas which lack available conventional sources of energy but have a wealth of wind or sunshine".[4]

4/ Resolution 885 (XXXIV) of 24 July 1962.

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